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Orangutan Infant Behavior: A Critical Component for Primate Conservation

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INTRODUCTION

Orangutans, *Pongo sp.*, are one of the four genera of the great apes (*Pongo, Gorilla, Pan,* and *Homo*). Orangutans are often differentiated from the other apes for their bright red fur. However, there are many factors which separate them from the other Great Apes. They are the only Asian great ape, residing in Indonesia and Malaysia, on the islands of Borneo and Sumatra. Orangutans are semi-solitary, arboreal brachiators, meaning that they live primarily alone and travel via swinging through trees (Thorpe and Crompton 2006). This allows them to cover a vast area in search for food. Adult orangutans require a large amount of fruit each day to survive and to reproduce efficiently (Thorpe and Crompton 2006). By living alone, orangutans are able to reduce food competition. Their requirement for a large habitat and resources has made orangutans highly susceptible to environmental threats. Similar to the other great apes, all species of orangutans range from endangered to critically endangered with approximately 112,000 total orangutans left in the wild (WWF 2017).

The reasons for orangutans' endangered status exceeds the change in their environment. Many are directly captured or killed by the hands of humans (Meijaard et al. 2011). Due to their rarity and intriguing demeanor, they are often a target for poaching for the pet trade. Growing palm oil plantation owners target and kill orangutans for attempting to eat the palm fruits (Meijaard et al. 2011). It is common for adult orangutans to be killed or be severely wounded in these scenarios. Orphaned orangutan infants lucky enough to survive the pet trade and palm oil plantations are sent to rehabilitation centers, where they finish up their childhood, with the hope that these orangutans will be able to be released back into the wild once they reach adulthood (Wich and Marshall 2016).

Most rescued orangutans are young, with 63-97% of overall rescues still in their infancy, below the age of 7 (Russon 2008). Necessary steps to improve orangutan numbers include improving the lives of the hundreds of infants in rehabilitation centers. Many infants in rehabilitation centers will be released once they reach adulthood (Wich and Marshall 2016). Since orangutans are semi-solitary, actively living alone except for mothers and their infants, it is believed that they learn solely from their mothers (Byrne et al. 1998). This makes infancy even more critical for orangutan development and survival in the wild, than for other great apes.

Rehabilitation centers try and replicate the conditions necessary for orangutan cognitive and social development of orphaned individual. However, there is still a lot we do not know about orangutan development due to limited studies of wild individuals. It was not until the late 1980's when rehabilitation centers began focusing on improving orangutan reintroduction by increasing orangutan infant research (Russon 2008). In order to raise these infants and improve their chance of reintroduction, we must increase our knowledge of their lives and development.

For my thesis, I looked at the level of development of two-year old, Redd, and his dependency on his mother, Batang, at the Smithsonian's National Zoological Park. The purpose of my study was to better understand orangutan learning through analyzing Redd's daily activities as well as mother-infant control. The frequency and nature of these interactions were assessed to examine the influence orangutan mothers had on infant behaviors. This may allow researchers and rehabilitators to understand the role mothers play in the different infant orangutan developmental stages, so attempts can be made to replicate of these actions in rehabilitation centers to improve reintroduction survival.

BACKGROUND

Orangutans (*Pongo pygmaeus, P. abelii, and P. tapanuliensis*) are among our closest living relatives, splitting from the rest of *Hominidae* only 16 million years ago (Hasegawa et al. 1985). The major characteristics of all the apes are a large brain and a long developmental period, which allow for complex social and cognitive abilities (Campbell et al. 2011). All species of great apes are endangered (IUCN 2019), with only 172,000- 300,000 chimpanzees and 100,000-200,000 gorillas left in the wild (WWF 2017). There are even fewer orangutans left in the wild. All three species of orangutans, *Pongo abelii*, *Pongo pygmaeus*, and the recently recognized, *Pongo tapanuli* (Nater et al. 2017) are currently endangered, with an estimated combined total of 112,000 left in the wild (WWF 2017). Studies of the great apes are used to understand not only our closest relatives themselves, but to understand our common ancestors and the characteristics we all share. Behavior research allows us to see what the fossil record cannot, such as social structure (Campbell et al. 2011). Unfortunately, we are at the risk of losing our closest relatives, leaving many unanswered questions behind. Steps have been taken to improve the numbers of the great apes, but without continuous efforts, they will all go extinct.

Ape Conservation

Great ape populations are severely decreasing at the hands of humans. The main threats to chimpanzees and gorillas are hunting and deforestation with human population growth. In addition to these, orangutan numbers have declined significantly due to growing palm-oil companies, whose construction results in severe deforestation and fragmentation for orangutan habitats (Sodhi et al. 2009). There is an increased urgency for orangutan conservation due to

rapid climate change, which is responsible for increased forest fires that exacerbate the diminishment of orangutan habitats (Erb et al. 2018).

Apes are generally directly targeted through hunting for bushmeat and the pet trade, as well as indirectly from disease transmission or harvesting from the land. This includes local peoples collecting resources and selling them, or from transforming forests into agricultural land (Redford et al. 2013). The largest contribution to the decline of orangutans is due to palm oil plantations. The creation of these plantations degrades the habitat, while the workers of the plantation shoot and attempt to kill orangutans who enter the plantations to eat the palm fruits (Sodhi et al. 2009). Human threats to ape species are heightened within areas with increased poverty since local residents use these methods for survival. Stricter protected areas reduce the resources that local people living in poverty depend on for their own livelihood, often causing them to participate in hunting and forest degradation activities regardless of legality (Redford et al 2013). In addition, many of these locations do not have the funding to enforce such existing laws, allowing for more people to continue harvesting the area (Sodhi et al 2009). This creates a dichotomy of protecting the great apes versus providing for the local population.

Previous Steps Towards Conservation

Several organizations exist that promote and support activities directed toward great ape conservation. The Great Ape Project, first published in 1993, consisted of essays by respected primatologists in order to achieve rights of the great apes. The specific rights proposed included: the right to life, the protection of individual liberty, and the prohibition of torture (Cavalieri and Singer 1993).

The Great Ape Conservation Act was passed in the U.S. in 2000. This act includes provisions for the The Great Ape Conservation Fund, managed by the U.S. Fish and Wildlife Service Division of International Conservation. This fund provides resources to conduct research and projects which benefit great ape research and ape habitat preservation. Projects range from putting money directly into ape conservation efforts as well as investing in projects which improve connections with local communities. In 2018, almost $5 million was donated to ape conservation projects (U.S. Fish & Wildlife Service 2019).

The Great Ape World Heritage Species Project, created in 2001, allows for great apes to be universally recognized as protected species. The Great Ape World Heritage Species project recognizes the needs of both orangutan conservation and the financial concerns of the local residents, highlighting the benefits to biodiversity that great apes have, as well as the appeal of great apes to the public (Wrangham et al. 2008).

It is often disputed among environmental researchers, conservationists and primatologists whether great ape species should be perceived as having human-like rights when other animals do not. Typically environmentalists stray from anthropomorphizing apes, compared to anthropologists who often compare apes to people. Anthropomorphizing apes can result in a conservation hierarchy, using ape human-like similarities to prioritize conservation. This can result in less conservation money for other organisms which, ecologically speaking, are just as important to conserve (Wich and Marshall 2016). However, ape conservation efforts are still lacking, due to a disconnect between humans and apes. To make these conservation efforts effective long-term, we must educate the public to prevent further killings of apes. A preventative approach for improving orangutan numbers will reduce conservation funds needed.

Ecotourism allows for increased public appreciation of the apes, allowing for further education of tourists on their interests in apes. It also serves to increase funds which are often circulated back into conservation, allowing for species survival projects to thrive. With regards to orangutans, Indonesia's National Development Plan, active from 2005-2025, provides a framework for improving ecotourism, with the goal of protecting the environment as a whole through practical applications of sustainable development (Republic of Indonesia 2017). Ecotourism can be valuable to local communities because it provides the option of the local population making money from the land without destroying it. This allows for both conservationists and local populations to benefit while improving ape conservation. Changing humans' perception on how to profit from the great apes is the only way to change ape-harming behaviors (Schultz 2011).

Orangutan Preservation

Among the orangutans there are only an estimated 104,700 individuals of *P. pygmaeus*, the Bornean orangutan. *P. abelii* and *P. tapanuli*, both found only on Sumatra, are critically endangered with only 7,500 and 800 left, respectively in the wild (WWF 2017). Decreased orangutan populations are mainly due to habitat loss (Sugardjito et al. 1986). With the rise of the palm-oil industry, the forest is increasingly being cut down and fragmented (Sodhi et al 2009). This fragmentation is detrimental to the survival of orangutans since orangutans rely on traveling across vast areas of forest in order to forage for food (Hardus et al. 2012). Bornean orangutan numbers alone have fallen by 50% between 1999 and 2015. Population decline is estimated at 750–3,500 individuals yearly (Meijaard et al. 2011). The rate of population decline increases

yearly, and without intervention, the orangutan will go extinct within the next 50 years (OFI 2019).

Reducing forest fragmentation may be the most important and effective method of conserving species. A study by Wilson et al. (2014) explores the cost of forest preservation compared to reintroduction of orangutan individuals back into the wild. They determined that land preservation was more cost effective and that it would be more beneficial in the long run to preserve land (Wilson et al. 2014). Hopeful land preservation estimations suggest that by implementing integrated land-use tactics, combining farm land with native plants, 51% of land on Borneo can be preserved. This is expected to save Borneo over $43 billion in farming costs (Runting et al. 2015). One difficulty with this proposal is that it would require cooperation over multiple countries, as Borneo is divided between Indonesia and Malaysia (Runting et al. 2015).

Orangutan conservation is crucial not just for the sake of their own survival, but also on an environmental level, as they are an indicator species. Their well-being reflects on the environment as a whole in which they live. In order to effectively conserve the rainforests of Sumatra and Borneo, the only places wild orangutans exist (Wich et al 2004), we must provide the conditions necessary for orangutans to live and thrive. Orangutan conservation can be improved by protecting orangutan habitats and by rehabilitating orangutans which have been harmed as a result of humans. While maintaining conservation land is important to the long-term survival of orangutans, rehabilitation centers still have increasing numbers of orphaned orangutan infants who need to be taken care of properly in order to be reintroduced. Because of this, it is necessary to take care of these individuals and rehabilitate them to the best of our abilities (Leong et al 2004).

The rising numbers of orangutan infants, combined with limited funding, leaves researchers and rehabilitators with difficult decisions. Palmer (2018) explores the costs of orangutan rehabilitation and the difficult decisions that need to be made. It costs around $44,000 to rehabilitate a single orangutan orphan, which is difficult to justify in an area where people are in poverty and the money does not exist. Options include raising as much money as they can to try and increase rehabilitation numbers, to stop rehabilitation and focus on other aspects of conservation, or to euthanize the orangutans in rehabilitation centers (Palmer 2018). If conservationists focus only on preserving land and not the orangutans we have currently, then orangutan numbers will continue to dwindle and the wild orangutan will soon cease to exist. Out of 1,250 orangutans released between 1964 and 2008, half survived reintroduction (Meijaard et al. 2011). In order to save the orangutan, ecotourism can serve as a funding method, allowing for dual focus on both conserving the land and improving rehabilitation. Critical for the improvement of these rehabilitation programs is understanding orangutan child development. It is during their childhood that the apes learn the skills necessary to eventually survive in the wild, whether it is from their mother, or in a rehabilitation facility.

Orangutan Infant Development

The especially long life history and semi-solitary social structure of the orangutan is a result of the large amount of resources and time needed for orangutan reproduction and infant development. Orangutan mothers must increase their calorie count during reproduction and raising of infants (Van Schaik 1999). It has been believed that female orangutans were only able to reproduce once every seven to eight years (Galdikas and Wood 1990). Recent studies show that their inter-birth interval is closer to 10 years (Wich et al 2004).

In orangutans, infancy, defined as the period of nursing, lasts up to the age of four to five years (Galdikas and Wood 1990). Once born, orangutan infants rely solely on their mothers for survival. They have the longest infancy of all of the apes of up to 7 years. During this time, infants are still nursing and remain in close proximity to their mothers (van Noordwik and van Schaik 2005). Captive orangutan infants will first break physical contact with their mother as early as 5 weeks. At this time, infants will begin climbing attempts (Miller and Nadler 1980). Orangutans will range with their mothers until the age 11. This means that for years at a time, female orangutans must be able to find enough resources for both her and her offspring. She will not immediately have another infant, even once the infant has stopped nursing (van Noordwik and van Schaik 2005). It is during their childhood, the infancy and juvenile periods, when most ape cognitive development takes place (Byrne and Russon 1998).

Despite developmental differences, all ape species initially learn from mother-infant contact through behaviors such as play and gestural communication (Hayashi and Matsuzawa 2017). During their first year, orangutan infants develop more solitary play than chimpanzees, who tend to play with other chimps. It is believed that the difference in orangutan infant development is linked to their semi-solitary lifestyle (Miller and Nadler 1980).

In one study by Bard (1992), communication between orangutan infants and mothers in order to manipulate and obtain food is tested in wild orangutans. Bard observed that, starting at the age of two, orangutan infants began to gesture to their mother for food, but waited until the mother was in a place convenient for her to give food. Prior to age two, orangutan infants would try to acquire food from their mother whether or not it was present. These gestures were learned in response to their mother's actions (Bard 1992). This demonstrates a well-developed

understanding of social protocols, even before age seven. Chimpanzees, in contrast, may learn gestures from their peers, not just the mother (Schneider et al 2012).

Infant Development in the other Great Ape Species

Extreme variation in infant development exists among the great apes. Chimpanzee infancy occurs slightly faster than orangutans, categorized as ending between the ages of four and five when they typically stop nursing (Horvat and Kraemer 1981). Where orangutans first break contact with their mothers as early as 5 weeks, the earliest break in contact recorded by chimpanzees was not until week 10. For both orangutans and chimpanzees, mothers initiated the first few breaks in contact, but returned to their infant once the infant whimpered (Miller and Nadler 1980). Between the ages of one and two, chimpanzees began to spend more time socializing with chimpanzees other than their mother, such as siblings and other infants/juveniles (Horvat and Kraemer 1981).

Like orangutans, gorillas learn specific tasks from watching and imitating their mothers (Byrne and Russon 1998). Even though humans share this learning characteristic, research with chimpanzees, our closest living primate relative, has not yet fully supported that they learn in this manner and are skeptical on the learning of all apes, as this is a very controversial topic (Schneider et al 2012).

A study by Maestripiere et al. (2002) explored infant-mother interactions among gorillas in three zoos in order to understand developmental learning. They concluded that, apart from mothers encouraging their infants to walk within their first few months, the gorilla infants were more active in their own learning, rather than their mothers pushing them. It was the infants that took an interest in the activities of their mothers, resulting in the infants repeating their mother's

behaviors. In chimpanzee and gorilla species, there are few reportings of active involvement of learning from mother to infants has been recorded, where mothers have taken inedible items out of their infants' mouths, or administering active teaching. Currently, there is no record of this in orangutan species (Maestripiere et al. 2002).

Social play among chimpanzee infants showed a higher rate of gestural communication between chimpanzee infants and non-maternal adults than for orangutan infants and non-maternal adults. This suggests that chimpanzee cognitive development relies heavily on social patterns of multiple individuals (Frohlich et al. 2017). In addition, orangutan infants spend about two times the amount of time with solitary play compared to chimpanzees. This also reflects their difference in sociality (Miller and Nadler 1980). Orangutans generally wean two years later than chimpanzees and gorillas, despite no other difference in developmental times. Difference of time spent weaning is believed to be a result of resource availability influencing their semi-solitary social structure (van Noordwijk and van Schaik 2005).

In the wild, male adult chimpanzees play an important role for infant development since they are often playmates for infant chimpanzees (Hayashi and Matsuzawa 2017). These relationships are not often formed until late infancy. Time spent with males depends on the age and sex differences between the infant and the male (Horvat and Kraemer 1981). Orangutan mothers do not allow adult male orangutans to serve as potential playmates for young, so male-infant interactions in orangutans would be rare.

Comparisons among orangutans, chimpanzees, and gorillas show the variation between infant development in great apes. From this, we can conclude that orangutans require specific traits necessary for infant development. Within the literature concerning orangutans, specificity

of the conditions under which orangutan infants learn and develop is lacking. More research is needed to improve our understanding of orangutan development.

The Difficulties of Orangutan Research

In the wild, orangutans are extremely hard to spot and track through the jungle, due to orangutans living approximately 100 feet up trees covered with foliage. Research is based on orangutan visibility, making it unavoidable to miss behaviors during a research study (van Noordwik and van Schaik 2005). Because of their long gestation period, infant research is also limited due to the lack of subjects. Orangutans, like humans, have long developmental periods. Female orangutans care for their children through their infant years and well into their adolescent years (Wich et al 2004).

Necessary Research Steps for the Survival of the Orangutan

Orangutans lucky enough to survive the destruction of their habitat are often orphaned individuals whose mother either died from forest fires, lack of food, or more directly by the hands of humans. In order to combat the extinction of orangutans, researchers have initiated the task of rehabilitation of orangutan orphans. In order to care for these individuals, it is essential to understand and replicate the conditions necessary for their survival as adults (Leong et al 2004). Although all studies of orangutans are valuable, many have focused on behavior over a long time scale rather than at instantaneous moments. Since orangutans have a long infancy, research rarely records the behaviors throughout the entire infancy period. However, orangutans are species that constantly learn, and the majority of their important skill sets develop before they reach their juvenile years (Russon 2006). By further understanding the necessities of orangutan

childhood development, rehabilitation centers can be better equipped to raise orangutans in order to release them into sanctuaries or back into the wild. These centers are crucial to the long-term conservation efforts of orangutans in the wild.

There is an urgency for understanding the conditions necessary for orangutan survival. Because of the few numbers of individuals left, researchers observe both captive and field research. In captivity, behaviors observed are typically heightened from those in the wild since zoos provide fewer threats and more resources than in the wild (Shumaker et al 2008), allowing research to show the limits of orangutan behaviors. Although the conditions of orangutan habitats are not exactly replicated from their life in the wild, captive research supplements observations of behaviors in the wild by showing the limits of orangutan behaviors. In captivity, behaviors are expected to be heightened from those in the wild since zoos provide less threats and more resources than in the wild (Shumaker et al 2008). However, research suggests no significant difference between orangutan development in the wild and captivity (van Noordwijk and van Schaik 2005). Currently, there is a rise in ape infant research which focuses on determining stages of infant development through proximity and contact of orangutans (Maestripiere et al 2002). Due to minimal mother-infant pairs, more research is needed.

This study centered on behavioral observations of the interactions between Redd, a Bornean Orangutan infant, and his mother, Batang. The purpose of this study was to answer questions such as: *What types of behaviors is Redd efficient at? How dependent or independent is Redd at two years old? Is Redd starting to spend more time away from his mother? What influence does his mother have on specific behaviors and learning?*

METHODS

Setting

This study occurred at the Smithsonian's Zoological National Park, Washington D. C., between the dates of June 7th - August 2nd. Formal data collection occurred between June 23th to July 27th, weather permitting. Temperatures ranged from 60 to 80 degrees. The number of visitors varied depending on the time of day and day of the week.

The location of data collection was dependant on the location of Redd and Batang within the zoo. The orangutan facilities at the zoo consisted of two main buildings, the Ape House and the Think Tank. The Ape House held four separate indoor enclosures and one large outdoor enclosure. Zoo keepers had the ability to open or close doors to each of the enclosures, allowing the circulation of orangutan groupings. The Think Tank included one large indoor enclosure and one outdoor enclosure. This building included an additional corridor, where orangutans would be encouraged to enter and perform tasks for live shows (Appendix A). Both buildings included fixtures which mimicked trees, allowing for orangutans to climb. In addition, enrichment objects were circulated daily in order to provide new objects for the orangutans to forage and play with.

Most of the orangutans housed at the zoo are allowed to travel between the Ape House and Think Tank buildings via the O-Line, a large cable structure spanning across the zoo which allows orangutans to travel via brachiation. Although zoo keepers could monitor which enclosures orangutans had access to, orangutans were able to choose if they wanted to cross the O-Line and visit Think Tank.

Orangutan's Housed at the Zoo

There were 7 individuals present at the National Zoo: 2 adult males, 4 adult females, and 1 infant (Appendix B). This study focused on the mother-infant pair Redd (2 years old) and Batang (21 years old). The two adult pairs, Iris and Kiko, Bonnie and Kyle, were able to move into enclosures containing infant Redd and adult Batang, when permitted by zookeepers. Neither pair had access to them at the same time. Adult female Bonnie would often break away from Kyle and travel alone into the enclosures containing Red and Batang. One adult female, Lucy, was not allowed to enter an enclosure containing other orangutans. When first introduced to the zoo and the other orangutans, Lucy had fought with the others. The decision was made to separate her from the others for safety purposes. Because Lucy was raised by humans, zoo keepers believe that her lack of social skills was a result of her improper socialization (Stromberg, personal communication).

Data Collection

Prior to formal data collection, I spent the first two days settling into my area of observation. I mapped out the enclosures (Appendix A), met with zoo keepers, and planned possible areas to collect data. I separated each enclosure into 9 sections to map the location of individuals during data collection. The next week was spent familiarizing myself with different orangutan behaviors in order to build an ethogram (Appendix C), and to match behavior categories with the orangutan behaviors present at the zoo. Specific codes were fine tuned in an ethogram to catalogue different types of behaviors. Each day of data collection, I would review the guidelines of the ethogram to reinforce strict data recording. Not all behaviors were present in my findings, but a thorough ethogram allowed me to compare my findings with other

research. Initial data collection occurred during the next week, allowing for learning the data collection techniques, and become reliable. A check for reliability occurred on June 27th with Dr. Ingmanson. Formal observations for data analysis began on June 23rd and ended July 27th.

At the beginning of each observational day, I recorded the date, weather, and overall atmosphere of the zoo in an *ad libitum* notebook. This included the approximate number of visitors present, which orangutans were within the same enclosure with Redd and Batang, and any other information which might influence different orangutan behaviors. At the end of each day, I recorded the overall events/behaviors that occurred in addition to the focal animal observations, allowing me to include important behaviors not occuring during the observation samples and expand on events if needed.

I conducted focal observations on Redd for the duration of this study. During each observational period, I used instantaneous sampling at one-minute intervals for 15 minute periods (Martin and Bateson 2007). Data was collected on two sheets: Daily Activity data sheets and Mother-Infant Control data sheets (Appendix D). On each data sheet, I recorded the type of behavior Redd exhibited. This included the location of Redd and Redd's proximity to any other orangutans in the area that might affect his behavior. Proximities were catalogued as numbers 1-5 (Appendix E).

Using Daily Activity data sheets, Redd's behaviors were recorded in one-minute intervals. In addition to behaviors and proximities, I recorded if any orangutan were the recipients of Redd's actions and included the specific nature of each with *ad libitum* notes. This allowed me to expand upon *how* Redd performed each task.

Data collected on the Mother-Infant Control data sheet also catalogued Redd's behavior and the proximity of Redd and Batang as well as Redd with the other orangutans. In addition,

this sheet included makes/breaks in contact and approaches/leaves of proximities, including who initiated each action. The number of data collection periods depended on the amount of time Red and Batang were able to be observed clearly. I recorded whether there was a partial or blocked view of subjects, but specific behaviors for those times were not used in analysis (Altmann 1974). I rotated between the two sheets throughout an observational day to strive for randomness within data collection.

Analysis

The remaining weeks of the research period were dedicated to analyzing the data and writing up my results. By examining the two data sheets, I can determine how much time Redd spent on each behavior type and if any of Redd's behaviors were influenced by his mother and/or other orangutans.

Using both the Daily Activity and the Mother-Infant Control data sheets, I created an activity chart for Redd by adding up the intervals spent on each behavior and averaged them to calculate a percentage of time for each behavior. From this chart, I was able to determine which of Redd's behaviors occured most frequently, then compared time spent on each behavior in order to determine which behaviors are prioritized. In addition, I compared how much time Redd engaged in dependant versus independent behaviors.

Data for contact were combined for each separate week for analysis. The same was done for proximity. A bar graph was created to compare Redd's time spent in contact and close proximity to his mother, as well as time spent with additional orangutans.

Using data collected on the Mother-Infant Control data sheets, I compared makes/breaks in contact and approach/leave data using Hinde's Index (Hinde and Atkinson 1970). Control and

proximity were combined for each week of observation. A bar graph was created to determine whether Redd or Batang was maintaining control of contact and proximity within each week. Comparisons of each week allow us to see if Redd's control changes over time. Comparisons between the mother-infant control of contact and proximity bar graphs can suggest potential influences of the presence of other orangutans on mother control.

RESULTS

Over a period of 4 weeks, between June 23rd and July 27th, approximately 30 hours of data was collected between both Daily Activity and Mother-Infant Control data sheets (Appendix D). Activity chart, Mother-infant control, and other orangutan present within Redd and Batang's enclosure were created.

Activity Chart

The majority of Redd's time was spent either playing, engaging in feeding behaviors, or environmental manipulation. Time spent in play categories included social play (15.75%), object play (6.00%), and locomotor play (2.43%; Fig 1). Of time spent engaging in play activities, 65% of play was social, 27% of play included an object, and 8% of play time Redd engaged in lone, or locomotor, play (Fig 2). The second largest category included food-related behaviors, with foraging at 13.09% (Fig 1). Feeding was only calculated at 1.45% due to simultaneous foraging/feeding behavior categorized under foraging (Fig 1). Environmental manipulation, including object manipulation, occured during 10.72% of the observational period. Mother-Infant travel (MI; 6.04%), and Nursing (4.01%) were present, although not as frequent.

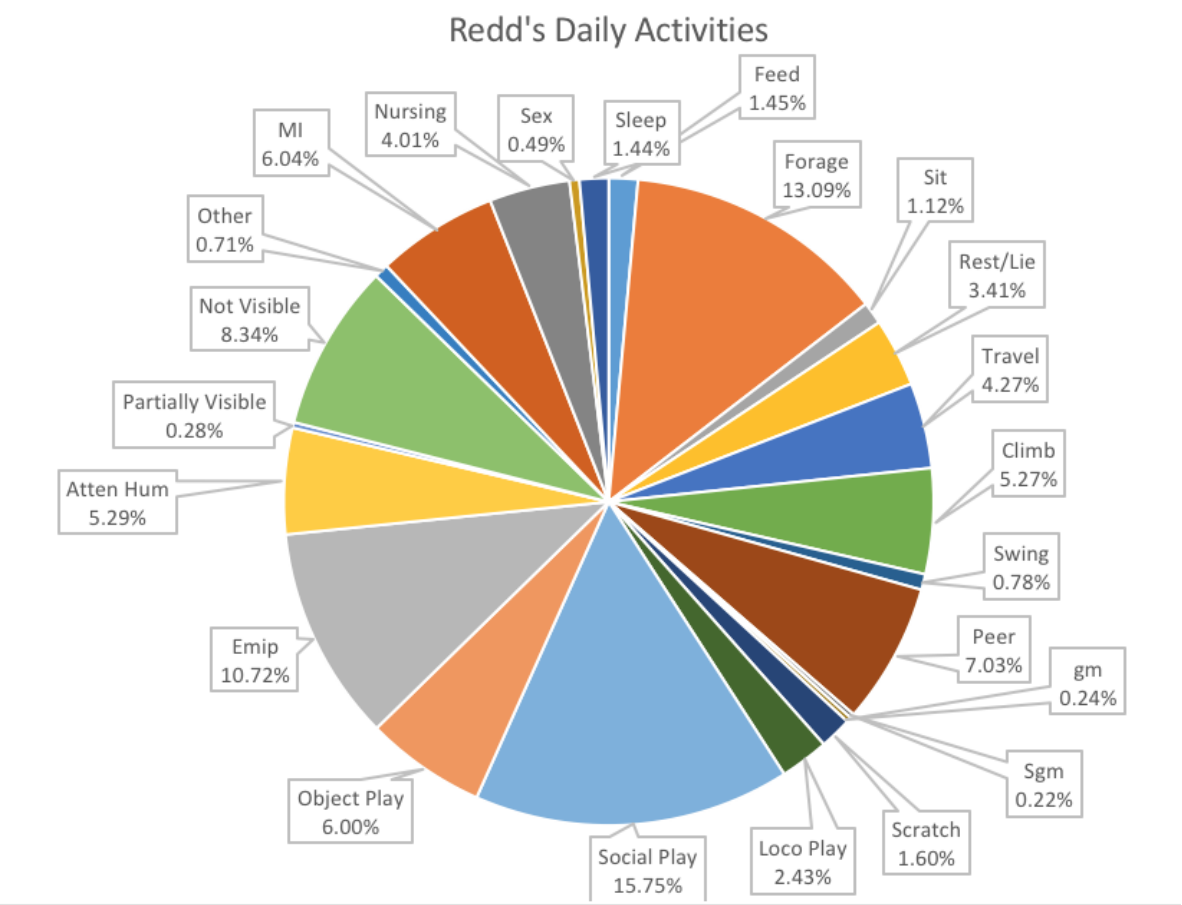

Figure 1. Activity Chart of Redd's Daily Activities. Data calculated from both Mother-Infant Control and Daily Activity Sheets. Data was only collected during zoo hours. This chart does not include night activities.

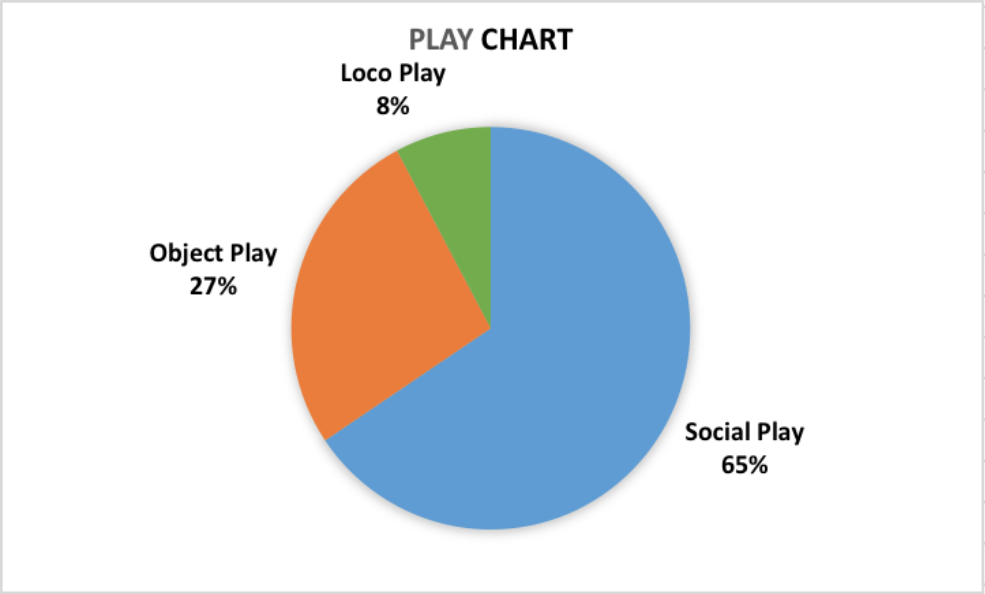

Figure 2. Percent of each type of play of overall play time, calculated from data used to construct Redd's Daily Activity Chart.

Mother-Infant Control:

Social control data was separated into four weeks. Week one contained 7 intervals, week 2 contained 7 intervals, week three 4 intervals, and week four consisted of 5 intervals of data collection. Within physical makes and breaks in contact the Hinde indices were as follows: week one 0.416, week two 0.303, week three 0.084, week four 0.182 (Fig 3). Hinde indices for approaches and leaves in contact for week one 0.299, week two 0.388, week three -0.138, and week four 0.024 (Fig 4).

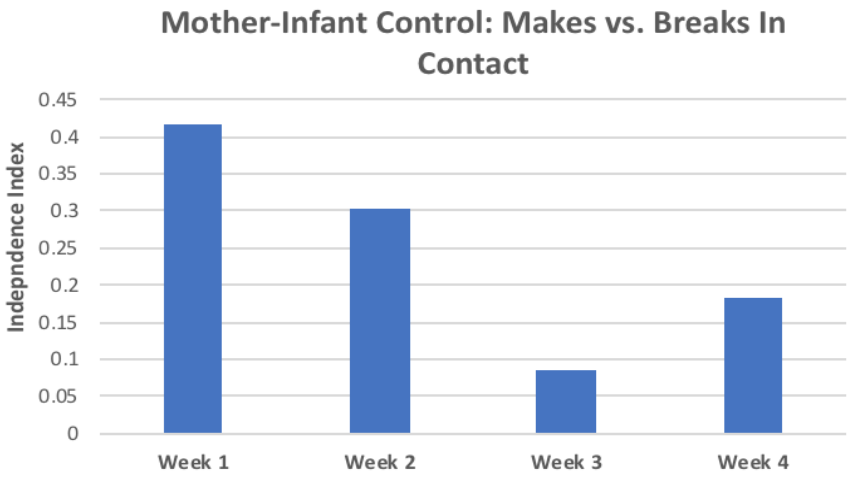

Figure 3. Hinde's independence index calculated for physical makes and breaks in contact of both Redd and Batang. Independence index > 0 suggests Redd maintaining control, < 0 suggest Batang maintains more control, = 0 suggests even control

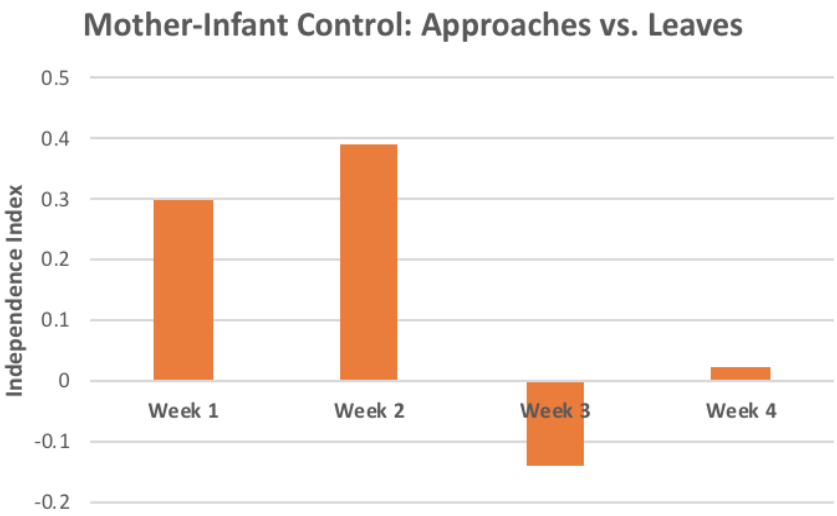

Figure 4. Hinde's independence index calculated for approaches and leaves of proximity between Redd and Batang. Independence index > 0 suggests Redd maintaining control, < 0 suggest Batang maintains more control, = 0 suggests even control.

Proximity to Other Orangutans:

Redd remained in the same enclosure as Batang throughout the observational study. Other orangutans frequently joined Redd and Batang, spending 43.64% of time during week 1, 52.00% of time during week 2, 100% of time during week 3, and 42.86% of time during week 4 within the same enclosure as them (Fig 5).

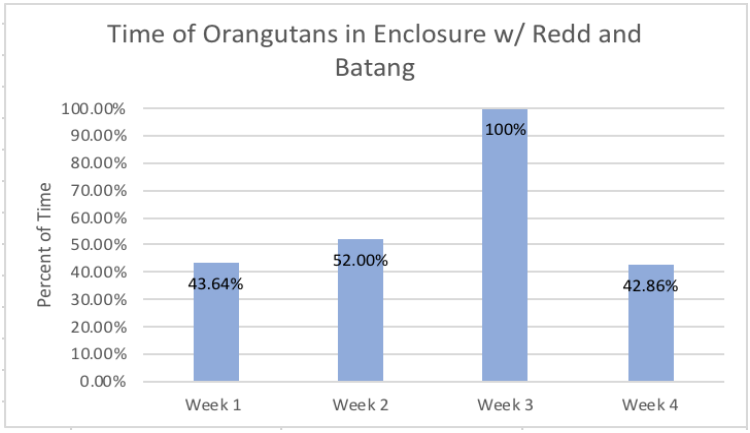

Figure 5. Redd and Batang's percent of time in Proximity to other orangutans, calculated from data used to construct Redd's Daily Activity Chart.

DISCUSSION

The purpose of this study was to look at behavior and social control to determine the behaviors critical to a two-year old orangutan infant. This includes understanding Redd's exploratory behaviors of his environment and other individuals and how these behaviors are impacted by the behaviors of his mother.

Activity chart

The activity chart demonstrates the amount of time (in percentages) Redd was spending exhibiting each behavior within a given day. Redd was spending a lot of time playing, foraging, and manipulating objects (Fig 1). These behaviors are important for learning, since practicing these activities will allow him to be efficient at feeding himself and will give him necessary social skills to function within his social group (Bebko and Russon 2015). Other important behaviors, including nursing, show Redd's continued dependence on his mother.

Play Behavior

Play behavior is essential for infant development because it allows the infant to investigate the limitations of himself, object, and social boundaries (Bebko and Russon 2015). In this study, play behavior was split into three different categories: social play, locomotor play, and object play. Play included activities which seemed to serve no other purpose than Redd's own amusement. In order to recognize play behaviors, Redd typically had a wide grin, showing his teeth, known as "play face" (Berdecio and Nash 1981). Play also included Redd slapping another orangutan, object, or the ground (Appendix C).

Social Learning: Although orangutans are seen as semi-solitary, there is a high importance of social skills during their development. Because of their large brain size, apes still experience cognitive development outside the womb, with the neonatal brain mass of 41.2% (Hayashi and Matsuzawa 2017). This development is immensely shaped by how they interact with their environment. (Bebko and Russon 2015) Social learning occurs through interactions the infant has with individuals within their social group. Infants use play behaviors to test the limits of the world around them. From social play, infants learn necessary social skills to function within their community. This includes social boundaries (Bebko and Russon 2015). In order to look at what social boundaries Redd was learning, I looked to the limitations of his social play. This included questions such as: *How do infant orangutans play? Who is Redd playing with? Who does he not play with? What factors contribute to the limits of social play?*

Social Play: Redd exhibited social play behaviors during 15.75% of the observation intervals. This is more time than he spent on foraging (13.09%; Fig 1). Social play consisted of wrestling behavior, bites, slaps, or pull at the mouths of the individuals with whom he was playing. Play was often initiated with a "play face" (Berdecio and Nash 1981).

Social play often occurred between Redd and Batang due to Batang's control over Redd, but later also included play with Bonnie. Attempts to play with the other orangutans (regardless of success) looked like Redd slapping at other individuals while Batang restrained him. Although his body was restrained by his mother, Redd's arms were not. This allowed some play between Redd and the other adult orangutans to succeed.

Learning About Sex: Social interactions allowed Redd to not only investigate and learn social limits, but to learn how to perform sexually. This behavior was observed infrequently at 0.49% of observed time. Sexual attempts were initiated by Redd and performed with both Batang and Bonnie. Redd is years away from reproduction, but he had an erection during these attempts. In Bonobos, sexual encounters within all sex and age combinations are frequent, allowing infants to learn sexual behaviors from their peers (Hashimoto 1997). Redd's attempts of copulations show that orangutans are learning *how* to copulate within their infancy. This can be critical for rehabilitated/released orangutans. If orangutans do not know how to reproduce, then they will fail to reproduce once they are released into the wild. The observation and practice of normal sexual activity is important for future successful reproduction. Improving offspring numbers of wild orangutans may depend on rehabilitation centers increasing the orangutan infants knowledge of reproduction.

Object Play: Playing with objects accounted for 6.00% of Redd's total activity time, occurring during 65% of his play time. Most of this play occurred using enrichment items placed within the enclosures. Enrichment was rotated daily, allowing Redd to investigate both familiar and unfamiliar objects. One recurring enrichment item which Redd enjoyed was a black tub full of soap and water. Redd would place his hand in the soapy water and rapidly spin it in a circular motion, creating more bubbles. The bubbles that remained on his hand were either licked off or slapped against the wall/viewer window. He would do this by swinging his body on a firehose, pushing himself towards the wall and slap the bubbles off of his hand and onto the wall. Batang also engaged in bubble-making. Redd may have learned this behavior via cultural-like transmission by watching his mother (Jaeggi et al. 2010).

Blankets were a more familiar object as they were present in the enclosure every day during this study. Blankets were used by the orangutans for many tasks, such as making nests to sleep in or wrapping themselves in them to either hide from other individuals or just for comfort. Batang was often wrapped within a blanket and would cover Redd in one in an apparent attempt to get him to nap. However, Redd did not use blankets this way. His main activity involving blankets was to utilize them for play. When in the Think Tank enclosure, which housed many platforms for Redd to climb on, Redd would use a blanket as a way to maneuver himself down a platform. He did this by swiftly climbing up a platform with a blanket, throwing the blanket across the platform, then jumping down by holding the blanket, letting it fall with him. Although this is a form of tool use, Redd used this solely in a repetitive manner with no survival-directed goal. The blanket was not used as a way to *safely* jump as Redd could easily jump down without it, but was used in a similar manner to a child using a slide. He repeated this action for many minutes at a time, showing a play face as he did.

We can learn a lot from this interaction. Redd's use of leveraging himself with a blanket shows his understanding of three-dimensional spaces. He needed to know that the height of the fall was not dangerous as well as where to place the blanket, so it would fall with him. This skill is essential to learn early in arboreal animals, since a misinterpretation of the space around them could result in death (Herbert and Bard 2000).

One important observation of object play which can show the level of Redd's cognitive abilities was Redd's interaction with a mirror. Mirrors are often used as a means of determining self-awareness (Anderson and Gallup 2015). Throughout the study, there was only one day when Redd encountered a mirror. It was a circle mirror that hung from a tree-like structure, allowing it to move if pushed by one of the orangutans. Redd used a fixture as a seat and sat in front of the

mirror. At first, he held onto the sides of the mirror and rested his face on it, periodically getting closer and moving away from his reflection. Then he began to show his teeth and attempted to engage in a playful manner, by showing his play face and attempting to lunge towards his reflection. It was not until he spun around the mirror multiple times and appeared shocked at the lack of orangutan behind it, that it was clear he did not know he was playing with his own reflection. Orangutans have the ability to understand their own reflection beginning at age three (Anderson and Gallup 2015). Redd had not yet gained this skill, but with prolonged exposure to a mirror, he may recognize his reflection within the next year. Continuing research will allow comparisons with Redd's understanding of objects during this study, examining the developmental time needed to understand such objects.

Locomotor Play: Locomotor play refers to any playful activities involving large, whole-bodied locomotor movements. This is different than object play, which included an object within the action. Locomotor play includes activities involving movements of one's body, such as doing somersaults, swinging, and jumping. Locomotor play accounted for 2.43% of his total observed time. This is much less time than he spent playing with other individuals. Redd only engaged in locomotor play when no other orangutan was around besides Batang. His play often occured after Batang ignored his initiations to play with her. Batang was typically foraging at this time.

Redd's time spent in play behaviors correlate with orangutan behavior patterns in other studies of both wild and captive orangutans, suggesting a normal progression of play activities (Herbert and Bard 2000). The limited time spent engaging in locomotor play emphasized the importance of social behaviors in orangutans. The lack of solitary behavior is reflected within

Redd's activity chart (Fig. 1). The only other time Redd spent not engaging with other individuals was during his time spent foraging.

Feeding Behavior

In the wild, orangutans must travel far distances in order to locate food (Jaeggi et al. 2010). For Redd, feeding behavior was often represented by active foraging of food within hay and inside of objects. Additional behaviors, such as environmental/object manipulation and object play are linked to feeding as well. These behaviors allow Redd to familiarize himself with tools and enrichment, which he can then utilize to obtain food in less accessible locations.

Foraging: Orangutans begin eating solid food around age 1, but continue nursing until age 7 years (van Noordwijk and van Schaik 2005). In the wild, the majority of time collecting solid food is spent in lone foraging. However, offspring typically follow their mother to locate food patches (Jaeggi et al. 2010). Redd spent 13.09% of time on lone foraging. This is important because it shows Redd's independence for collecting and eating solid food. Within the ape species, it is very rare that a mother will actively hand food to their offspring (King 1994). Although, some studies suggest that Bornean Orangutans may hand food to offspring up to 6 months of age (King 1994, Jaeggi et al. 2008). Throughout my study, Batang was never once observed handing food to Redd. Any solid foods he obtained were taken himself either from the enclosure or from grabbing it out of his mother's mouth. Often it appeared as though Batang allowed Redd to take the food from her own mouth. This food theft tolerance is typical in many primates (Feistner and McGrew 1989).

Nursing: Redd was still nursing at the time of this study, as expected. All nursing events were initiated by Redd. My study did not focus on the types of food he consumed nor the caloric intake. This study does not determine where the majority of his nutrients are coming from, but time spent acquiring them. Similar to the other apes, orangutan infants can spend a large portion of the night nursing (van Noordwijk and van Schaik 2005). Since my study was limited to the daytime hours, these nocturnal feedings are not reflected in my data. Although Redd was witnessed spending 4.01% of observation time nursing, this study cannot account for the added nursing time expected nursing throughout the night. Redd's foraging behaviors show some independence, although he is still early in his infancy stage.

Environmental Manipulation

Environmental manipulation, separate from object play, occurred when Redd changed his environment to serve an apparent purpose. This included the use of enrichment objects to obtain food inside them. Redd manipulated his environment 10.72% of observed time. This is in addition to the 6% of time spent on object play. By investigating his environment, he is learning how to use and manipulate his environment to obtain food, skills that would be needed to obtain imbedded foods in the wild.

Imitation

Active teaching is rarely witnessed among the great ape species. Instead most learning is through careful observation and imitation (Russon and Galdikas 1995). Although Redd did not create or manipulate tools during this study, one observation occurred related to this. Redd attempted to lift a stick that his mother had been using to poke at (investigate) the vents beyond

the cage. His attempt was a few minutes after Batang had stopped using it. However, the stick was too large for him to lift and he abandoned it. This behavior suggests possible imitation. There was another instance where Batang had gotten ahold of a pitchfork and had used it to smash an exit sign beyond the enclosure. Redd did not get a chance to attempt imitating this behavior, as the pitchfork was quickly taken away from Batang. It will be interesting to see if he imitates this tool use in the future.

Social Control

Social control refers to which individual in a relationship controls their proximity to each other. This relates to the amount of freedom Batang allows Redd to have, depending on the individuals near him. During the beginning of infancy, orangutan mothers will have complete social control over their offspring, meaning that she dictates when they are allowed out of contact or proximity to her (Horwich 1989). Social access to other orangutans will determine the types of behavioral cues an infant will learn from them (Russon and Galdikas 1995). The amount of maternal control should decrease over time and is crucial to the proper development of infants, both apes and humans (Horwich 1989, Hayashi and Matsuzawa 2016).

Maternal Control

The use of Hinde's Index allowed for comparisons between control of physical makes/breaks in contacts and approaches/leaves in proximities between two social individuals (Hinde and Atkinson 1970). For this study, Hinde's index was used to look at mother-infant control between Redd and his mother, Batang. Positive indices would suggest that Redd initiated most of the control, negative indices would suggest Batang initiated most of the control, and

indices bordering zero would suggest even control between the two. Change in which orangutan retained control was expected, depending on the change in their environment and Redd's increasing age.

Redd demonstrated most of the control within weeks one and two. During week three, there appears to be a push-back from his mother. The indices shows Batang regaining control of Redd's movements (Fig 3 - 4) Bonnie was the only other orangutan within the enclosure with Batang and Redd. Since Batang had already allowed Bonnie into Redd's social circle, it was surprising that Batang regained control. This may be due to Batang's caution of losing control, and her attempts to regain it. Batang may have felt overwhelmed by the continuous presence of Bonnie, whereas weeks 1, 2 and 4 provided Redd and Batang a break from the other orangutans within the same enclosure as them (Fig 3 - 4). During week four, Redd's control began to increase once again. It is expected that this control and lack of control will fluctuate until Redd has more control overall. This is typical in both great ape and human infant development, where the gaining of new skills and control are interspersed with periods of regression (Horwich 1989). Learning new skills may cause the regression of another, since most of the brain focus will be spent on the new one. In addition, amounts of time in contact with mother and nursing vary within the first two years of development. As a result, the infant will appear to have a fluctuating amount of control, nursing, and efficiency in performing specific tasks (Horwich 1989).

Social Control When Other Orangutans are Present: When any orangutans other than Bonnie were present in the same enclosure as Redd and Batang, Batang had complete control over Redd. She monitored him by physically holding Redd with one of her feet or by physically restraining him by lying on top of Redd, using her body weight to hold him down. During physical

restraints, Batang would typically stare at the orangutan opposite them. Batang demonstrated which orangutans Redd was able to associate with based on her control/lack of control over him when other orangutans were present. Typically, when Bonnie entered the enclosure, Batang would allow Redd to have contact with Bonnie. This meant that Batang had accepted Bonnie into their socal circle.

Redd and Male Orangutans: Batang was especially careful around adult male orangutans. She used physical restraint on Redd when either male orangutan, adults Kiko and Kyle, were present. Redd had no physical contact with either orangutan throughout this research period. Male orangutans are twice as large as females (Delgato and van Schaik 2000). Possible explanation for Batang's restraint may have to do with the size difference between Batang, Redd, and the males. In addition, males are also aggressive towards females with infants, with some cases of suspected infanticide (Knott et al. 2010). The males at the zoo were witnessed displaying by throwing barrels and loudly barging into a given enclosure. These behaviors demonstrated how dangerous the males can be. By limiting Redd's contact with the males, Batang may be protecting Redd from their strength. These limitations may influence Redd's perception of male orangutans throughout his life. By Batang providing differential cues which distinguish between threatening and non-threatening individuals (King 1994), Redd learns who to avoid. As Redd increases his social circles, he may learn how to react to specific behaviors exhibited by the other individuals, e.g. avoiding males when they are displaying. This may shape any caution or tolerance to other males that Redd may have as an adult.

Redd and the Other Female Orangutans: Early in this study, if either the two adult females, Bonnie and Iris, were present, Redd was still restrained by Batang. But he was often in a close enough proximity to Bonnie and Iris that he could reach out and attempt to play with them. This changed after June 28th, when Batang no longer restrained Redd, allowing him to play with Bonnie, without being in a close proximity herself. This only occured if Bonnie was the only orangutan present besides Redd and Batang. Batang did not leave Redd alone in the enclosure with Bonnie, but would stay at distances up to 20 ft away from Redd and Bonnie. During the research period, this only occured with Bonnie, never to Iris. Batang allowing Redd to engage with Bonnie was not solely attributed to Bonnie being a female, but to Batang's acceptance of Bonnie.

Possible Allomothering

Alloparenting refers to parenting activity by an individual who is not related to the infant they are parenting (Moore 1991). Alloparenting can allow for increased care time for an infant and can open up more time for the mother to raise a second offspring, or to get food or rest (Quinlan and Quinlan 2008). This is seen in gorillas where their shorter inter-birth interval may be due to alloparenting by the father (Nowell 2019). Social learning for Bornean Orangutans is believed to occur primarily between mother-offspring due to their solitary nature (van Noordwik and van Schaik 2005). By only learning from one individual, an orangutan infant will only learn the information that has been passed down to their mother. Due to temporary aggregations of orangutans in the wild (Sugardjito 1986), there is a possibility that orangutan infants can acquire knowledge from other individuals. In addition, Sumatran orangutans exhibit somewhat more social behaviors and social learning then in Borneo due to a difference in food abundance (van

Noordwik and van Schaik 2005). Although *P. pygmaeus* is not known for alloparenting in the wild, interactions with Bonnie suggests that alloparenting may be possible.

One study at the Dublin Zoo, Whilde and Marples 2010, catalogued a successful fostering of a three year old orangutan infant after its mother died. The infant began spending more time with another adult female whom she previously had contact with. The infant spent three times more time in contact with the foster orangutan than prior to the mother's death. In addition, the infant slept in the same nest and suckled from the adult female (Whilde and Marples 2010). This shows that, given the opportunity, adult females can assume the role of mother for orphaned orangutans.

According to personal accounts from the zookeepers at the Smithsonian's National Zoo, Bonnie and Iris were both prepped to be surrogate mothers in the case that Batang was unable to care for Redd. Bonnie had previously raised an offspring, Iris had not. Along with Batang, they were coached by zookeepers to ensure the proper handling of Redd, by allowing her to practice with dolls. Right after Redd's birth, Batang did not handle him correctly until they were placed into the same enclosure with Bonnie. Bonnie may have facilitated Batang's learning, due to maternal behaviors Bonnie exhibited towards all the orangutans (Stromberg, Personal Communication). This bond between Bonnie and Batang likely contributed to Bonnie being was allowed to play with Redd first. Further research should highlight if Redd gains similar relationships with the other female, Iris, in the exhibit. Lucy and Redd's relationship would not be able to be observed, since Lucy is not allowed within enclosures containing any other orangutan.

Ideally, rehabilitated orangutans would each have a human acting as an orangutan foster mother. This is not feasible due to the large number of orphaned orangutans, the lack of workers

and lack of funding (Yeager 1997) Rehabilitation centers operate with workers raising individuals within orangutan groups, where orangutans are paired with one or more workers, taught ecological skills, and are slowly "weaned" from people (Wich 2016). Methods of effective alloparenting by female orangutans may be critical for the development of orphaned orangutans. In addition, a social circle containing mother and female orangutans may serve as valuable practice for new mothers. Currently, there are very few successful orangutan reproductions that occur within captivity (Russon 2008).

Redd versus Wild Orangutans

Captive research allows us to more easily research behaviors which occur in the wild. Although captive conditions contain less resource stress, it appears that infant development patterns closely reflect the ones in the wild (van Noordwijk and van Schaik 2005). In the wild, orangutan infants typically reach independence in nest building and locomotion by age three (van Noordwijk and van Schaik 2005) Redd showed locomotor competence at age two. Initial field work by Ingmanson (personal communication) observed two-year old orphaned orangutan, Jarwo, showing proficiency in climbing. Unlike Redd, Jarwo exhibited the beginning stages in nest-building (Ingmanson, personal communication). Stress may account for this behavior difference between Redd and Jarwo.

CONCLUSION

Redd, at approximately two-years old, is exhibiting a similar developmental route as other orangutans. Expected behaviors include increased foraging but still nursing-dependant, an increased social circle, presence of environmental manipulation, and a strong understanding of

three-dimensional spaces shown by locomotor proficiency. Redd is slowly gaining independence, although still reliant on his mother for learning, nursing, and guidance. Normal regression periods with his independence are seen.

Continuing research will look at the amount of time spent per behavior over time as well as further change in social control. With long-term data collection of Redd and other orangutan infants, we can create a better understanding of the conditions necessary for orangutan infant development. A closer study into alloparenting and imitation may suggest possible methods of raising orangutan infant in unconventional settings, such as rehabilitation centers. Long-term data will allow for a better understanding of the developmental requirements of orangutans, allowing for improved rehabilitation and reintroduction strategies.

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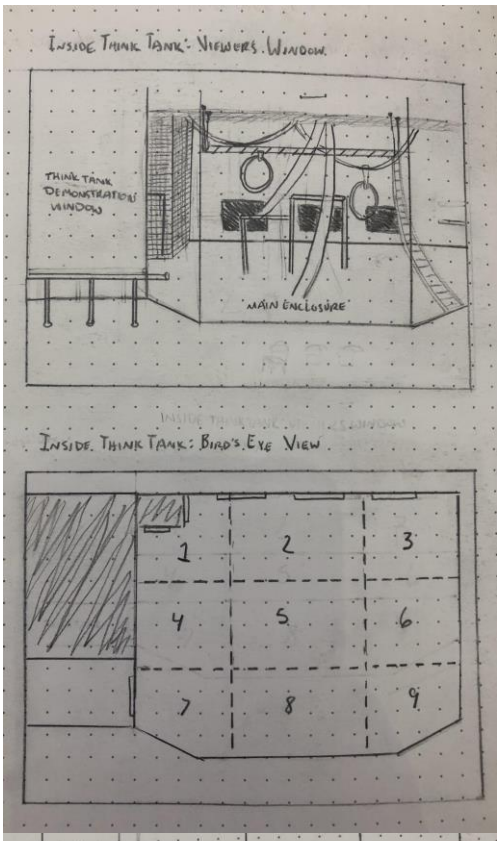
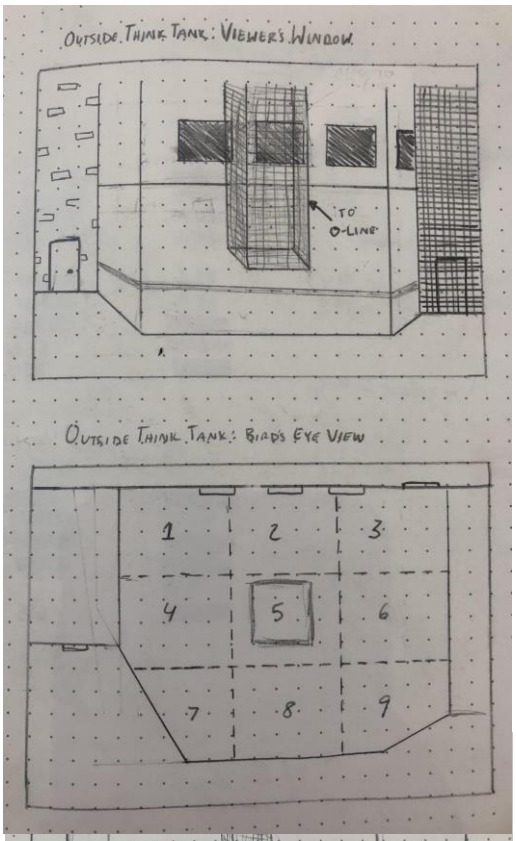
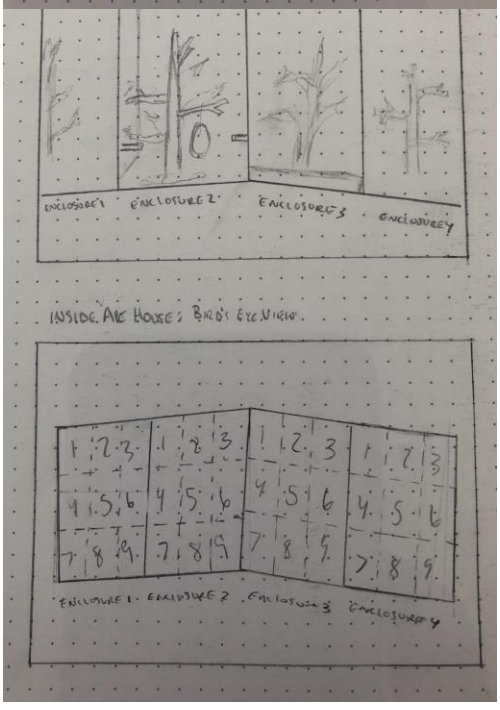
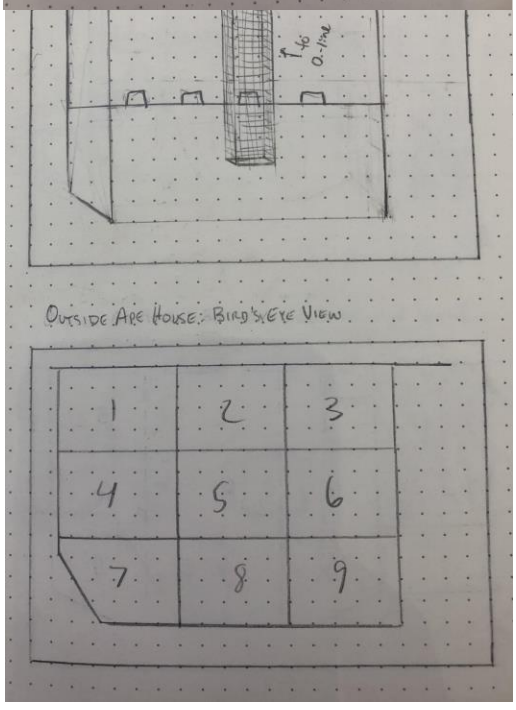
APPENDIX

Appendix A









Appendix B

Redd	Bornean orangutan infant, born September 12, 2016. His mother is Batang.
Batang	Adult female Bornean orangutan, born December, 1996. Redd is Batang's son. Batang is a first-time mother.
Bonnie	Adult female hybrid orangutan, born in 1976. Mother of Kiko. Bonnie either spends her time with Kyle or with Redd and Batang.
Iris	Adult female hybrid orangutan, born April 15, 1987. Iris spends most her time with Kiko.
Kyle	Adult male Bornean orangutan, born December, 1996. Sired Redd via artificial insemination. Kyle spends a lot of time in the same enclosure as Bonnie.
Kiko	Adult male hybrid orangutan, born 1987. Kiko has a close friendship with Iris.
Lucy	Adult female hybrid orangutan, born in 1973. She is not allowed to enter enclosures occupied by the other orangutans.

Information provided by nationalzoo.si.edu

Appendix C

Behavioral Activity Codes and Ethogram

FD - Feed	Individual is actively feeding, putting food into mouth
DR - Drink	Individual is actively drinking liquid (water, juice), nursing not included
FOR - Forage	Individual is actively searching for food. This included eating and searching when occurring simultaneously
TR - Travel	Individual moves between locations, generally in a quadrupedal manner, (walk, run, brachiation)
CL - Climbing	Individual is moving in a vertical direction (climbing or jumping)
ST - Stand	Individual is inactive and standing in a quadrupedal position
SIT	Individual is inactive and in an upright, sitting position
REST/LIE	Individual is inactive, in a prone position, an appears to be resting, but not asleep. Any other activity supersedes this category.
SLP - Sleep	Individual is clearly asleep, with eyes closed.
SHIFT	Individual may be sitting/laying down, but is fidgeting, shifting positions, moving extensively, but not engaged in any other activity.
G - Groom	Target individual is grooming another; picking through the hair or skin and removing debris with hands or mouth.
g - Being groomed	Target is the recipient of grooming behavior from another individual
G/g - Mutual groom	Two individuals simultaneously groom each other
SG - Self groom	Individual is grooming self, but not scratching
SCR - Scratch	Movement of fingers back and forth across the skin, generally with finger nails
PR - Peer	Close visual inspection of something, may be another individual or an object
EMIP	Explore, manipulate, investigate - the active exploration, manipulation or investigation of an object. May include tool use, nest building. Give explanation under notes
PLK - Pluck	An aberrant behavior that involves the pulling out hair, more

	forcefully than may occur during grooming. May be repetitive or rhythmic in motion
G/PLK	Focal individual plucks while simultaneously grooming another - though as a separate mtin. The plucking may be oneself, while also engaged in grooming the other individual.
g/PLK	Plucking while being groomed by another
AG - Aggression	Any of several behaviors that involve active aggression directed towards another individual. Includes threats. Displays, and attacks - push, hit, grab, slap, chase, bipedal swagger, etc, which are agonistic in nature. Explain in notes.
SB - Submissive	Any submissive behavior such as a crouch, bow, avoidance, presents
AM - Amicable Touch	Touch, embrace, greeting, reassurance - behavior that may ease tension or relieve stress in social situations
PL - Play	Social play behavior. Non-aggressive interactions between two or more individuals that may be accompanied by play face, laughing, repeated bouncing or poking, chasing
SP - Solitary Play	Locomotor play
OP - Object Play	Play with an object
SX - Sex	Present, mount, mount with intromission, genital inspect, masturabate
RK - Rock	Repeated rhythmic motion of the body. May be back and forth, or side to side. May include clutching of items, individuals or self.
MI	Motherng mother-infant type behaviors directed towards others, including allomothering, interest/inspection of infants, or carrying infants
N - Nursing	Either a mother whose infant is suckling/ on the niple, or an infant who is on the nipple
ATTEN H - Attention to Humans	The individual is focusing on humans in the environment - may be a keeper or visitor
NV - Not Visible	Individual is located out of the observer's view
BO - Bad Observation	Target individual is visible, but observer cannot clearly see behavior. May be behind environmental structure or other individuals.

OTH - Other	Any other behavior that occurs that does not fit into establish category, such as defecation or urination

*Ethogram adapted from one provided by Ellen J. Ingmanson

Appendix D

Orangutan Focal Observations

Target Animal: _____ Date: _____
Observer: _____ Time: _____
Weather: _____ Temp/Humidity: _____
Public Present: _____

Time	Activity	Recip	Vocal	Locat	Proximity to Others in Group			Comments

Daily Activity Data Sheet

Prox M	Prox O	Behavior	Contact: Make I → M	Contact: Make I → O	Contact: Make → I M	Contact: Make → I O	Contact: Break I → M	Contact: Break I → O	Contact: Break → I M	Contact: Break → I O	Proximity: Approach I → M	Proximity: Approach I → O	Proximity: Approach → I M	Proximity: Approach → I O	Proximity: Leave I → M	Proximity: Leave I → O	Proximity: Leave → I M	Proximity: Leave → I O	Brief Touch I → M	Brief Touch I → O	Brief Touch → I M	Brief Touch → I O	M → I Rict	M → I Rctr

Mother-Infant Control Data Sheet

Appendix E

Infant proximity to other individual(s)	Description
1	nursing
2	Making physical contact without nursing
3	Within arms reach , but out of touch
4	10-15 feet apart
5	Over 15 feet apart